technology has been accumulated at the Deutsches Museum in Munich, and in 1910 the committee of direction decided to publish a series of biographies of men whose work has had a special bearing on these subjects. The first volume to appear deals with the life and work of Georg von Reichenbach, to whom many advances, not only in the construction of astronomical and surveying instruments, but also in engineering, were due. Born in 1771, his education was carried on not only in school, but also in the workshop with his father, where he showed remarkable mechanical aptitude. At the age of twenty he was sent to England to study mechanical engineering, and in the works of Boulton and Watts in Soho he spent some months working at engine construction. While in England he had not had an opportunity of seeing the works of the leading instrument makers, but availed himself of every opportunity to study this industry also. Ramsden, Troughton, Dollond, Cary and others then supplied the greater part of Europe with instruments of the highest grade, but on his return to Munich he founded workshops for constructing instruments of precision, and for accurately dividing circles.

In the latter part of the eighteenth century a large amount of surveying was done, and in 1801 a base-line 21·7 km. long was measured near Munich for the systematic survey of Bavaria, so that von Reichenbach found his opportunity. The work of Laplace, Gauss, Bessel and others introduced a great increase in the precision aimed at and attained, and Reichenbach successfully constructed theodolites for the Bavarian survey with circles up to twelve inches in diameter; he was acquainted with Ramsden's great 36-in. theodolite which was constructed for General Roy, but apparently preferred the smaller instrument.

Throughout his work Reichenbach adhered to the vernier in preference to the micrometer microscope for astronomical as well as for geodetic instruments on the ground that with the former the portion of the circle was directly measured, while the micrometer measured the enlarged figure of the divisions. The circle of his 12-in. theodolite for the Bavarian survey was divided to five minutes and was read by a vernier to four seconds and by estimation to two. The triangulation of northern Bavaria called for the construction of a base-measuring apparatus, and in 1807 von Reichenbach constructed one consisting of iron 4-metre bars to be placed almost in contact, the interval being measured by a thin graduated wedge.

Large astronomical instruments were also constructed for Naples, Genoa, Turin, Mannheim and elsewhere, and are described as being among the best of that time. A very fine range of instruments, both astronomical and geodetic, is included in the collections of the Deutsches Museum. But, as Gauss remarked in a letter written to Bessel from Munich, the construction of astronomical instruments was not von Reichenbach's principal occupation.

Engineering machinery took up more of his time and attention, and in 1808 he constructed water-pressure pumping engines for the salt-works of Riechenhall and Traunstein, and others of improved design were built, and one of these, at Ilsauk, is still working. Iron-bridge construction and steam-engine design and construction also engaged his attention, and in many spheres of activity von Reichenbach showed remarkable originality and brilliant capacity. His family has presented to the Deutsches Museum a large collection of writings, drawings and plans, which have been extensively utilised in the present monograph, wherein Dr. W. von Dyck has produced not only a highly interesting account of a man of exceptional ability and resource, but has also rendered available a large collection of valuable and important documents relating to the construction of instruments of precision and of machinery, and some of these are reproduced in the plates which illustrate the monograph.

PURE AND APPLIED CHEMISTRY.

(1) *Chemistry of the Oil Industries.* By J. E. Southcombe. Pp. ix+204. (London: Constable and Company, Ltd., 1913.) Price 7*s.* 6*d.*

(2) *Achievements of Chemical Science.* By Dr. J. C. Philip. Pp. vii+217. (London: Macmillan and Co., Ltd., 1913.) Price 1*s.* 6*d.*

(3) *Le Celluloïd et ses Succedanés.* By W. Main. Pp. 162. (Paris: Gauthier-Villars, 1913.) Price 2.50 fr.

(4) *Ausführing qualitativer Analysen.* By Wilhelm Bilz. Pp. xi+139. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1913.)

(1) THIS work fulfils in a very satisfactory manner the author's attempt "to fill a gap between the elementary text-books of organic chemistry and the numerous technical treatises and monographs of a highly specialised character." The opening chapter on the chemistry of the hydrocarbons and their derivatives will facilitate the reading of later sections by those not very conversant with organic chemistry, but, in the interest of these readers, exception must be taken to the use of the expression "rests," in reference to unsaturated groups or complexes (pp. 14–15). The adoption of this Germanism is quite unwarranted, inasmuch as the idea can

be accurately expressed in ordinary chemical English.

The next chapter contains much interesting matter concerning the origin and chemical nature of mineral oils, and the principles underlying the commercial methods of oil-refining. Under the heading of saponifiable oils and fats a very judicious selection has been made of the most important members of a very large group of substances derived from both animal and vegetable sources. The analytical methods employed in testing these materials are briefly described, and in several instances illustrations are given of the apparatus employed. The industrial applications of fats and oils are classified, special attention being paid to the various commercial processes of hydrolysis, and to the purification of the higher fatty acids by distillation in superheated steam.

In the section devoted to soap and candle manufacture the author shows how the phase rule and recent discoveries in colloid chemistry can be applied to elucidate the reactions of the soap-pan. Reference is also made to the part played by adsorption complexes in the detergent action of soap.

Looking to the future, the production of petroleum motor spirit by the thermal decomposition of heavier hydrocarbons is suggested as a promising problem for research.

(2) The present volume is one of a series of "Readable Books in Natural Knowledge," the author's theme being the usefulness of the chemist to the community. It is to be hoped that this work will assist in dispelling the deplorable ignorance still existing in the minds of many of the British public in regard to the nature and scope of the chemist's activities. Although on the Continent the difference between "chemiker" and "apotheker" or between "chimiste" and "pharmacien" is well understood, in the United Kingdom the chemist is still usually assumed to be a person who of necessity trades behind a window ornamented with large bottles containing various coloured solutions.

After referring to the work of the pioneers of modern chemistry, the subject of combustion is discussed with the object of showing that this typical chemical change includes not only the burning of ordinary combustibles, but also such phenomena as fermentation, the rusting of metals, and the drying of certain oils. In this connection alone the chemist may with advantage be consulted by the farmer, the coal exporter, the cloth manufacturer and other industrial workers in regard to difficulties arising in the ordinary course of their avocations.

The irrational mode of domestic heating with smoky coal leads the author to recommend "coalite" (semi-coke) or gas-fires. A human note is touched by the remark that the latter are regarded with disfavour because they cannot be poked and nothing can be thrown into them. A more serious objection to gas-fires is suggested under the heading of secondary fuels, namely, the grave risk of poisoning arising from faulty gas-fitting and the high percentage of poisonous carbon monoxide present in modern illuminating gas.

The achievements of inorganic synthetic chemistry receive adequate attention. It is pointed out that by a curious coincidence the year 1828 witnessed not only the synthesis of urea, but also the successful manufacture of artificial ultramarine. The natural pigment from lapis lazuli, which was once worth its weight in gold, is now replaced by the synthetic product sold at less than thirty shillings a hundredweight.

The admirable detective work performed by the analytical chemist in bringing to justice the sophisticator of food is noted with the appreciation which this public service deserves.

(3) This volume, which forms one of a comprehensive series of scientific pocket-books, gives a summary of the manufacture of nitrocellulose and its conversion into celluloid by means of camphor and other adjuvants. The inflammability of this material, which is now employed on an enormous scale in the production of cinematograph films, has led to many processes having for their object the preparation of non-inflammable celluloid substitutes. Viscose (an alkaline solution of viscoid) is now manufactured from wood pulp, soda ley, and carbon bisulphide. Acetocellulose, the product of the acetylation of cellulose, has been placed on a commercial basis in the Elberfeld colour works, after seven years of research. Galalite, prepared by precipitating casein with formaldehyde, can be obtained in a transparent condition by first removing mineral salts from the casein by successive treatment with alkalis and acids. The condensation products of phenol and formaldehyde, when indurated to the desired extent by heating under pressure, give rise to the valuable plastic material "baekelite." The work is of interest as showing the extent to which the celluloid industry has developed in France.

(4) Although this guide to qualitative analysis contains a certain amount of useful information, the matter is not arranged in such a way that it can be readily followed. The group reactions, for example, would be more easily grasped if given in tabular form. Very little attempt is

made to furnish theoretical explanations of the various analytical reactions. A few practical details may be quoted as illustrating modern tendencies in laboratory practice. The difficulty of separating nickel and cobalt is overcome by using dimethylglyoxime to precipitate the former metal, whilst the latter is identified in an ethereal extract with ammonium thiocyanate. There is a reversion to an old process in the removal of phosphoric acid from the precipitable metals by means of tin and nitric acid. Absolute alcohol is used to remove calcium nitrate from the mixed nitrates of the alkaline earths. G. T. M.

THE FLOW OF SUBTERRANEAN WATERS.

Le Principe du Mouvement des Eaux Souterraines. By J. Versluys. Traduit du hollandais par F. Dassesse. Pp. 147. (Amsterdam: W. Versluys, 1912.) Price 7 francs.

CALCULATIONS concerning the flow of subterranean water have almost invariably hitherto been based upon the classical law of Darcy, published in 1856—a law which states that the quantity discharged is directly proportional to the head, and inversely proportional to the thickness of the stratum traversed. The terms are simple, and, for general purposes, are sufficiently close approximations to the truth.

It has been demonstrated more than once that the "law" is not absolutely exact, and, in several cases, the divergency from experimental results has been considerable. The law, in fact, has manifest limitations. Darcy omits all reference to temperature, and, indeed, it is doubtful whether he was acquainted with the experiments of Poiseuille, although these had been published ten years earlier, in 1846. The results obtained by Poiseuille led that investigator to conclude that the mean velocity of the fluid depended, in part, on its specific gravity and also on the temperature.

The object of the author of the brochure before us has been to review the situation in the light of recent research, as exemplified by the work of King, Richert, and others. He investigates, in the first instance, the purely theoretical problem of water-flow in its most general form. Then the various numerical results published in the literature of the subject are collated in a form suitable for comparison with the calculated results, and where pronounced divergences occur, observations and explanations are furnished. Finally, for strictly practical purposes, the author gives a series of numerical coefficients for use in cases where merely general approximations will serve.

The book consists of thirteen chapters and is a most painstaking and valuable compilation of the data at present available on the subject.

OUR BOOKSHELF.

Das Relativitätsprinzip. Zweite vermehrte Auflage. By Dr. M. Laue. Pp. xii+272. (Braunschweig: F. Vieweg und Sohn, 1913.) Price 8 marks.

THE second edition of Prof. M. Laue's book on relativity, though on the same plan as the first edition of 1911, contains several additions. In chapter ii. a short discussion of a second arrangement of the Röntgen-Eichenwald experiments is inserted. The kinematic part of the theory of relativity, chapter iii., shows some slight explanatory extensions in § 6, and an enlarged discussion of the inadmissibility of propagation of any physical effects with a velocity exceeding that of light (§ 7). The "cause and effect" point of view here adopted, which leads to a rejection of any hypervelocity of propagation, seems somewhat too narrow. At any rate, it prevented the author from considering the admirable researches on relativistically rigid bodies of M. Born, and especially of Herglotz. In § 8 we remark a fuller exposition and illustration of the notion of "proper time."

In chapter iv. the vector product of two six-vectors and the four-dimensional "Gauss theorem" are inserted. Chapter v. contains, besides a few minor additions, a considerably extended treatment of the theory of the Trouton and Noble experiment, and a much amplified exposition of four-dimensional potential-theory, following the lines of a paper by Sommerfeld. Chap. vi. contains but a few new lines (on pp. 148–164), while vii. (Dynamics) contains many changes and ample additions, viz., Minkowski's dynamics of a point-mass, remarks on the foundations of the dynamics of continuous bodies (§ 27), and the rotational momentum, with a pair of instructive examples, several minor additions in the following paragraphs, and finally the chief addition to the first edition, namely, relativistic hydrodynamics, giving the general equations of motion, and treating the interesting special case of fluids "of smallest compressibility," both essentially on the lines of a paper by Dr. E. Lamla (*Ann. d. Phys.*, vol. xxxvii., p. 772, 1912).

The Dictionary of Entomology. By N. K. Jardine. Pp. ix+259. (London: West, Newman and Co.) Price 6*s.* net.

THIS useful compilation is a glossary of the technical terms used in describing the structure of insects throughout their several stages. Within the limits which the author has imposed on himself it is likely to be of much service to students of entomology. These limits, it is true, are somewhat narrow; there is no mention of individual species of insects, or of genera or families. The orders, when given, are defined in the briefest possible manner, and frequently there is no indication of the insects comprised in them. The words "Coleoptera" and "Lepidoptera" find a place, but there is no mention of Dermaptera, Odonata, Homoptera, or Heteroptera. Hemiptera and Neuroptera are given, but beyond a bare defini-